

The 0.75m Telescope Control System

**A User's Guide and Supplement to the WinTCS Operations
Manual**

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March 2008



Figure 1: The 0.75m telescope with the UCT CCD mounted below it.

Contents

1	Introduction	1
1.1	Introduction	1
1.2	Brief Description of the Telescope and its Control Systems	2
2	Telescope Control	5
2.1	Overview of the Telescope’s Support Systems	5
2.1.1	Telescope Power	5
2.1.2	The Motor Driver Chassis	5
2.1.3	The Auxilliary Controller	5
2.2	Getting Started	8
2.2.1	Logging in and Start up	8
2.3	The Observing Procedure	10
2.3.1	Movement of the Telescope	14
2.3.2	Saving and Loading an Object Library	14
2.4	Adjusting Parameters	16
2.5	Shutting Down	19
2.6	Tips and Points-to-Note	19
3	Using the UCT CCD to Fine-Tune Telescope Focus and Position	21
3.1	The University of Cape Town CCD (UCT CCD)	21
3.2	Target Acquisition for Fine-Tuning Position	21
3.3	Setting Focus	23
4	Troubleshooting and Known Issues	25
4.1	Troubleshooting	25
4.2	Known Issues	27

4.2.1	Pointing Problems and the WinTCS Auto-Initialisation Procedure .	27
5	Quick Set-up Guide/Procedure	29
6	Useful Contacts	33

Chapter 1

Introduction

1.1 Introduction

This document describes the operation of the SAAO 0.75m telescope's new (as of 2006) telescope control system.

In 2006 the 0.75m telescope underwent a software and hardware refurbishment to allow better control of the telescope and its peripheral components. This manual provides an overview of the new system (later in this chapter) and describes the use of the WindowsTM-based telescope control software (TCS), WinTCS, for target acquisition (chapter 2). In addition, a quick guide to target acquisition using the 0.75m in conjunction with the UCT CCD is provided (chapter 3) along with a troubleshooting guide and description of known issues (chapter 4). For experienced users, chapter 5 is the quick start-up guide. For queries or problems relating to various subsystem components, the last section provides a list of useful contacts.

What this is and what it isn't

Please note that this manual is essentially meant to be a user's guide to operating the telescope and to supplement the DFM engineering WinTCS operations manual. Copies of the WinTCS operations manual are kept in the 0.75m dome and in the on-site technicians offices on the observing plateau. It is strongly recommended that the operations manual is read in conjunction with this user's guide. This is not a technical guide, though some known technical issues which affect the performance of the telescope are briefly discussed

here.

1.2 Brief Description of the Telescope and its Control Systems

The 0.75m telescope is a Grubb Parsons equatorial English mount reflector. The telescope's secondary mirror delivers a Cassegrain focus with an f ratio of f/15. A photo of the 0.75m with the UCT CCD mounted at the Cassegrain focus is shown on the inside cover of this manual. The right ascension (RA) drive is a single stage of worm gears driven by a stepping servo motor through two timing belts and pulley stages. The hour angle (HA) encoder is driven off the worm shaft. The declination (Dec) drive is a chain drive and the Dec encoder is driven off this via a sprocket.

Prior to the 2006 upgrade, the switching of dome power, dome tracking, lights, and movement of focus position was done manually. Opening of the shutter was done via a manual switch and the mirror cover was removed by hand. Movement of the telescope was controlled via a DOS based interface.

The 2006 refurbishment has provided:

1. An upgrade of the 0.75m's previous DOS-based TCS to a WindowsTM-based TCS. The TCS, named WinTCS and provided by DFM engineering, allows for more user-friendly control of the telescope and PC control of the focus, dome, lights and mirror cover.
2. The installation of a new position encoding system which enables self-automated intialisation of the telescope. This is useful to use in the event that the telescope loses pointing during observations.
3. A Programmable Logic Controller (PLC) box to manage the telescope peripheral subsystem. That is the PLC box:
 - implements (via a radio) PC control of the dome shutter, lights and mirror cover,
 - facilitates the safeguarding of the peripheral subsystem from behaving unpredictably following power outages or TCS failure,

- and enables the addition of a rain sensor to initiate an emergency shut down procedure on detection of rain.

The next section details the setting-up of the telescope and its support systems for target acquisition.

Chapter 2

Telescope Control

2.1 Overview of the Telescope's Support Systems

2.1.1 Telescope Power

Power to the telescope drives and motors are switched via two switches. The first (master switch) is on the left-hand wall just as you walk into the dome (at the bottom of the stairs). This switches power to the switchboard. The second is a push-button switch situated on the black Grubb-Parsons box at the top of the stairs and this switches power to the telescope drives, the Motor Driver Chassis (MDC, see below) and the computer monitors. The TCS machine, situated in the MDC, is on UPS.

2.1.2 The Motor Driver Chassis

The Motor Driver Chassis (MDC) is the big black rack inside the dome just outside the warm room (as shown in the photo, Figure 2.1). An interface card plugged into the PC controls the motor driver chassis. The chassis houses the TCS PC, power supplies and the control logic hardware for the motors which interfaces to the PC and the handpaddles. The PC has two monitors and keyboards: one set inside the dome on top of the rack and one inside the warm room.

2.1.3 The Auxilliary Controller

The Auxilliary Controller is the large panel-box mounted on the outside wall of the warm room, next to the MDC. It houses the PLC system which interfaces, via radio transmitter,

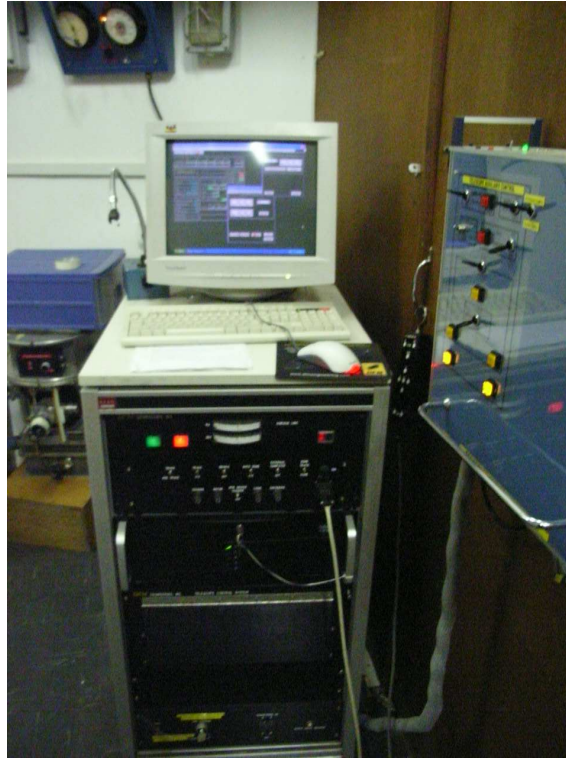


Figure 2.1: The Motor Driver Chassis situated in the Dome. The Auxilliary Controller box can be seen mounted on the wall on the right-hand side.

to the control box on the dome and manages the peripheral systems (safety, mirror cover, dome lights and shutter).

On the panel there are a number of toggle switches:

- MANUAL/AUTO
- DOME LIGHTS on/off
 - >Fluorescent Lights/Circle Lights
- EMERGENCY SHUT-DOWN on/off
- RAIN SENSOR on/off
- MIRROR COVER open/close

and a few buttons:

- DOME SHUTTER open
- DOME SHUTTER close
- WIND BLIND open
- WIND BLIND close

The operation of the various peripherals is summarised below.

Mirror Cover

If MANUAL control is selected the mirror cover can be opened and closed from the Auxillary panel. The TCS controls the mirror cover only if there is power to the telescope and the Auxillary panel is switched to AUTO mode.

The Auxillary Controller is programmed to close the mirror cover whenever the dome shutter is in the act of moving. However, **it should be noted** that, after the dome shutter has stopped moving that the mirror cover will revert to the position it was in when the TCS was issued the command to open or close the dome shutter. The danger here is that a telescope operator, on requesting the dome shutter to close and seeing the mirror cover close at the same time, will not notice the cover **re-open** after the dome is closed.

Hence a telescope operator must *always* check the status of the mirror cover after any movement of the dome shutter to ensure the cover is in the desired position.

Dome Lights

As in the case of the mirror cover, the dome lights can be switched from the Auxillary panel if the system is in MANUAL mode. The TCS can only control the dome lights if the Auxillary panel is switched to AUTO mode and the DOME LIGHTS are switched to OFF. The 'Fluorescent Lights/Circle Lights' switch toggles between the fluorescent lights on the dome ceiling and the red lights on the walls encircling the dome floor.

Dome Shutter

The dome shutter can be opened either manually from the Auxillary panel (using the buttons in MANUAL mode) or from the TCS when in AUTO mode. The TCS can only open the shutter when the PLC senses there is power to the telescope drives.

Emergency Shutdown

The EMERGENCY SHUTDOWN switch should normally be in the OFF state. When switched ON it triggers automatic shut-down of the dome shutter and mirror cover and disables power to the telescope drives. To re-cover from EMERGENCY SHUTDOWN, the telescope power must be re-started with the EMERGENCY SHUTDOWN switch turned to OFF.

The Rain Sensor

A rain detector was added as part of the upgrade to the peripheral system. The circuit is closed when the surface becomes wet. In this case the circuit switches the Emergency Shutdown routine implemented by the PLC. **NB:** The rain sensor must ***always*** be switched to **ON**.

When the rain sensor is triggered the mirror cover and shutter can not be opened, not even manually, without first powering down the telescope and restarting the system.

2.2 Getting Started

2.2.1 Logging in and Start up

Powering up the telescope

Switch on the power to the telescope drives to by switching the push-button on the black Grubb-Parsons box in North-West corner of the dome. On the MDC, make sure the toggles switches are set as follows:

- Switch MTR DRIVER CHASSIS ON (white toggle switch)
- Push HALT MOTORS button out (this switches the motors on, the switch should now be red)
- Switch DRIVES ON (Switch up)
- Set DOME TRACK to HOME
- TRACK (telescope tracking) must be set to OFF

On the Auxillary controller box mounted on the wall next to the MDC make sure that the switches are in the following configuration:

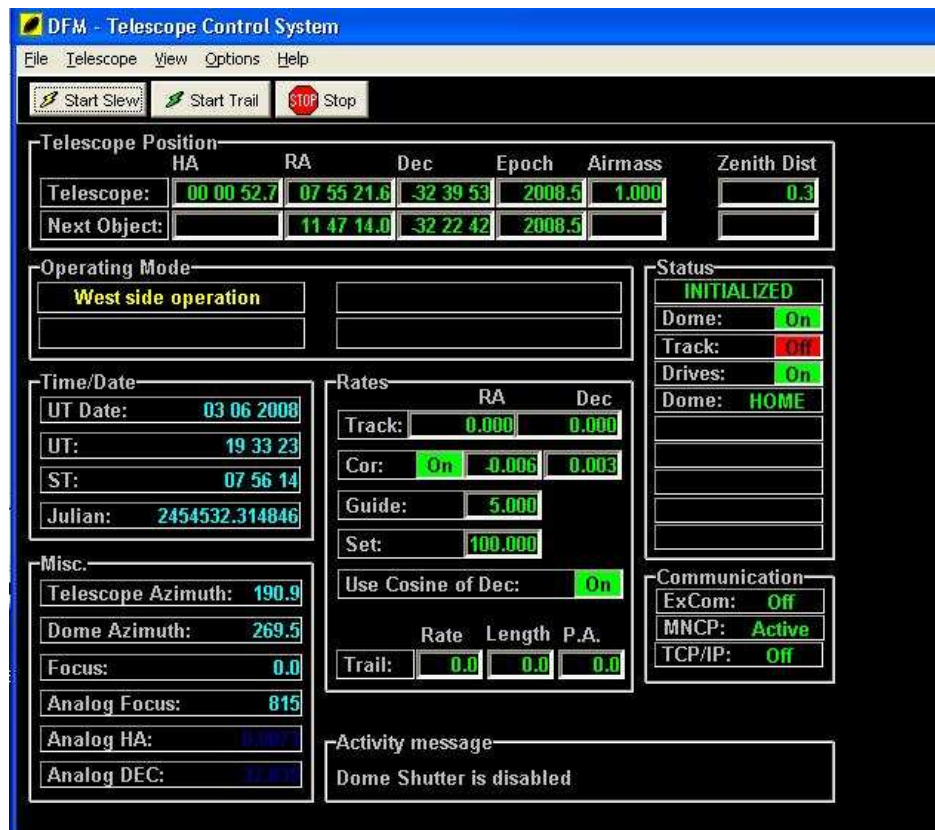


Figure 2.2: The WinTCS main screen.

- MANUAL/AUTO toggle switch set to AUTO
- RAIN SENSOR toggle switch set to ON
- EMERGENCY SHUT-DOWN toggle switch set to OFF
- DOME LIGHTS switched to OFF and CIRCLE LIGHTS
- MIRROR COVER set to CLOSE

Logging into WinTCS

Login to WindowsTM as observer, password: Saaobserver. Start WinTCS by double clicking on the yellow DFM TCS shortcut on the Desktop. WinTCS's main window opens up as displayed in the Figure 2.2.

The current telescope position in HA, RA and Dec (and epoch of the coordinates) is shown in the status bar, titled ‘Telescope Position’ across the top of the panel. Universal and sidereal time are shown on the left-hand side in the box titled ‘Time/Date’. Dome and telescope position coordinates in degrees, as well as the focus position, are also shown on the left-hand side in the box title ‘Misc’. The status of the MDC switches are shown on the right-hand side in the box titled ‘Status’. The current activities of the telescope and dome (eg. initialising, opening the dome shutter etc) are shown in box at the bottom of the main window (titled ‘Activity Message’).

2.3 The Observing Procedure

WinTCS works as a menu-based TCS. The items ‘File’ and ‘Telescope’ on the menu bar allow you to save data relating to target positions and to control the telescope parameters respectively. These are the only two items relevant to the observing procedure, and hence referred to in the rest of this document. The ‘Help’ menu item provides an electronic version of the DFM operations manual.

Rough Initialisation: Using the laser and pointer

Note: WinTCS initialises assuming that the dome is parked west and the telescope is pointing at the zenith.

You can only move the telescope and dome using the handpaddle if the WinTCS window is open. So:

- If the telescope and dome aren’t in the correct positions on start-up, first start WinTCS.
- Move the dome shutter using the handpaddle so the dome slit is aligned with the arrow on the West wall.
- Then switch on the laser located at the base of the telescope, near the telescopic-viewfinder (it has a red push-button). Move the telescope using the handpaddle so the the laser point on the West wall is in the center of the four-arrow target on the wall.
- Now close and re-start WinTCS. The dome shutter position will now be re-initialised to 270 degrees and the telescope initialised to the zenith.

Note: On closing of WinTCS, the program automatically closes the dome. If the dome is already completely closed, just click the ‘Stop’ button on the main menu and WinTCS will close immediately.

Opening up

Always make sure the lights are switched off first. (**Note:** First make sure that WinTCS can control the lights: the toggle switches on the Auxillary Control box should be set to ‘AUTO’, ‘DOME LIGHTS’ switched to ‘OFF’ and ‘CIRCLE LIGHTS’ as outlined in the previous section) On the menu go to ‘Telescope’ – > ‘Misc’ – > ‘Doors/Lights’ (as show in Figure 2.3, bottom panel) and under ‘Lights’ click ‘Off’.

Then go to ‘Telescope’ – > ‘Misc’ – > ‘Focus/Harmonic/Shutter’ as displayed in Figure 2.3 (top) Under ‘Dome’ click ‘Open’. Once the dome is fully open, go to ‘Telescope’ – > ‘Misc’ – > ‘Doors/Lights’ and under ‘Mirror’ click ‘Open’.

Initialising the Telescope

Time

First set the TCS time. WinTCS doesn’t use the CPU clock to keep time, but it’s own internal counter, which doesn’t keep time accurately over long periods (longer than ~ day). Hence the Universal Time should be set at the beginning of every run.

Go to ‘Telescope’ – > ‘Intialisation’ – > ‘Date/Time’ (see Figure 2.4). Set the date and time (Note: time is in UT) using the Universal Time server clock display situated in the dome or warm room and click ‘Apply’.

Fine Initialisation: Using the Telescope Auto-Initialisation Feature

As part of the 2006 refurbishment, a new position encoding system was installed on the 0.75m which allows automated intialisation of the telescope. Using the auto-initialisation system to initiate automatic initialisation of the telescope is described below. The operation of the telescope’s position encoding system, and known problems using the system, is briefly described under the ‘Troubleshooting and Known Issues’ chapter.

To initialise the telescope using the WinTCS auto-initialisation feature:

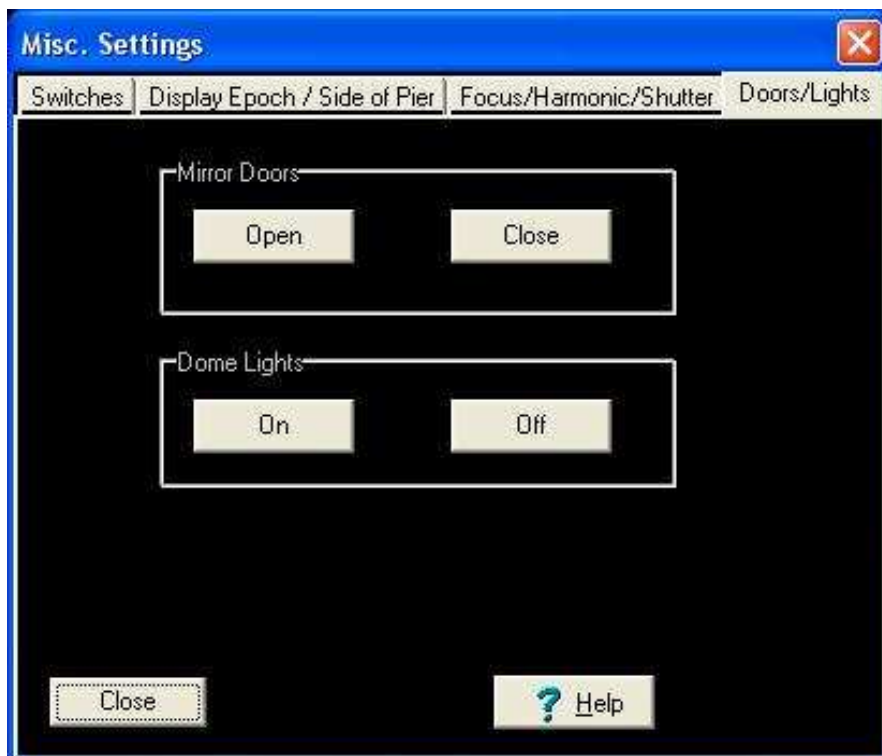
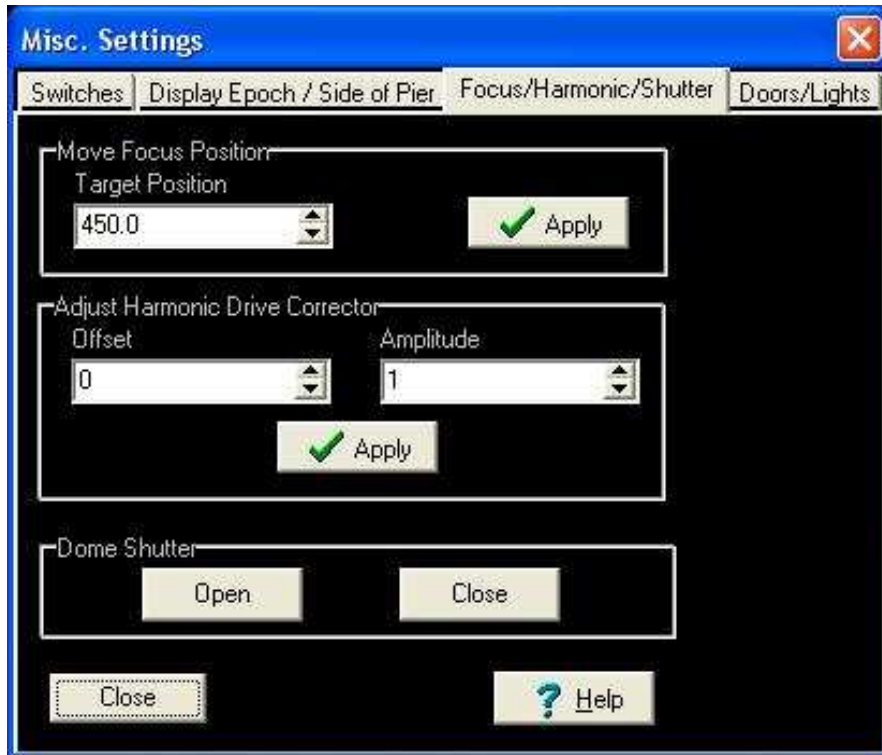


Figure 2.3: Opening up the dome shutter and mirror cover from WinTCS .

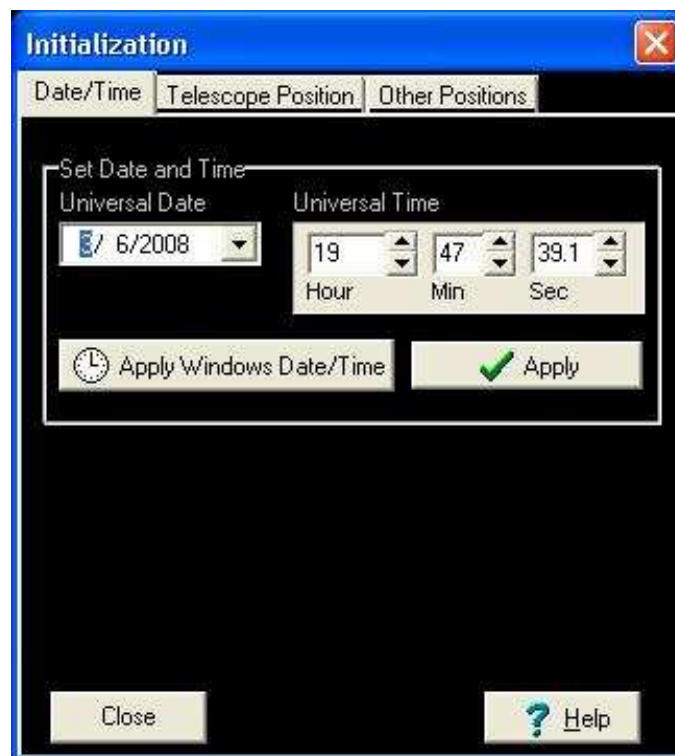


Figure 2.4: Setting the date and time on the ‘Initialisation’ screen.

- Go to ‘Telescope’ – > ‘Initialisation’ – > ‘Telescope Position’ (as shown in Figure 2.5). **Note:** Make sure that the TRACK is set to **OFF** on the MDC front panel.
- Then click on ‘Initialise with Fiducials’ and wait for the telescope to find the HA and Dec fiducials.
- Once the telescope has stopped tracking (and the status bar at the bottom of the main TCS window reads ‘ENCODERS SET’) go to ‘Telescope’ – > ‘Movements’ – > ‘Offset/Zenith’, click on ‘Slew to Zenith’ and ‘Apply’ (Figure 2.6, bottom panel).
- Once the telescope is back at the zenith, go back to ‘Telescope’ – > ‘Initialisation’ – > ‘Telescope Position’ and re-initialise using the fiducials again (see the ‘Troubleshooting and Known Issues’ chapter as to why this should be done twice).

The telescope should now be initialised and ready for observing.



Figure 2.5: Initialising the telescope position.

2.3.1 Movement of the Telescope

To move the telescope to a target position, go to ‘Telescope’ – > ‘Movements’ – > ‘Set slew position’ (Figure 2.6, top panel). Input the RA, Dec and Epoch of the target. Click “Apply”, the star’s coordinates should appear as “Next Object” on the Main menu (top) and “SLEW ENABLED” should appear in the status bar. Click “Start Slew” from either the Movements menu or the Main menu (they can be left open concurrently).

2.3.2 Saving and Loading an Object Library

Create a folder under the ‘My Documents’ directory for your own object libraries (called ‘Mark/Move’ tables in WinTCS).

Create your own tables by filling in your object’s coordinates in the blank table under the ‘Telescope’ – > ‘Movement’ – > ‘Mark/Move Table’ (Figure 2.7, top panel). The disk icons, ‘Save Mark File’ and ‘Save Mark As’ work in the same manner as ‘Save As’ and

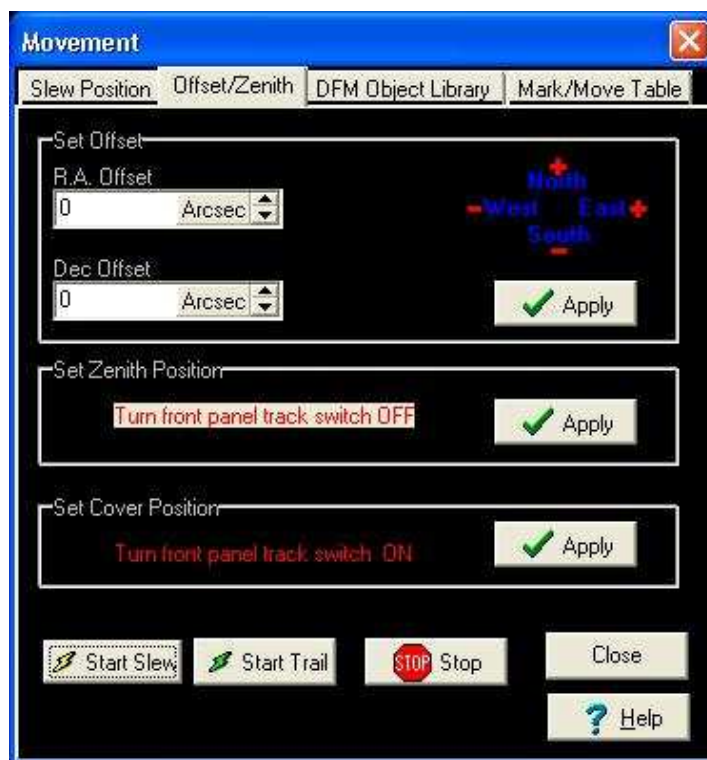
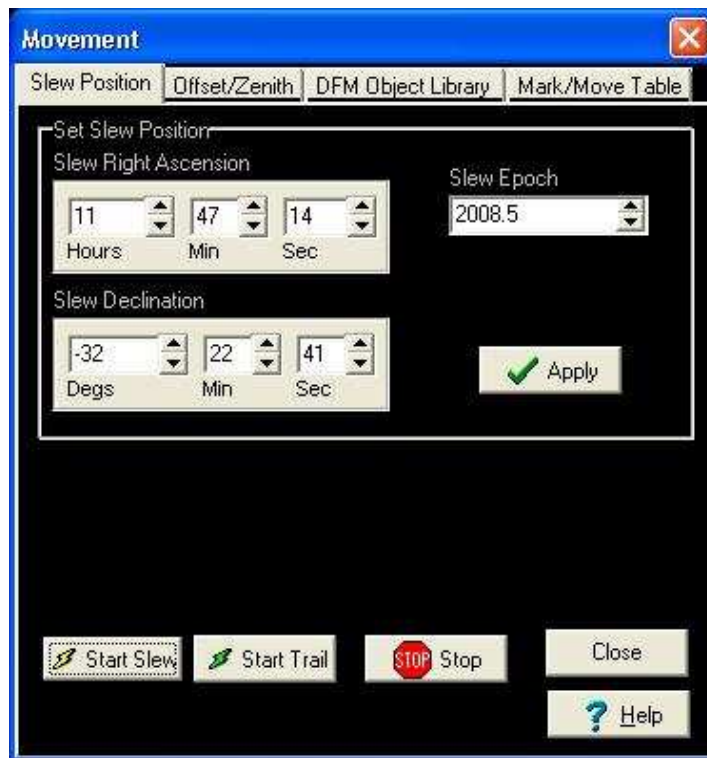


Figure 2.6: The WinTCS movement panel. Slewing to a target position (top) and slewing back to zenith (bottom).

‘Save’ respectively (I know, the reverse of what you expect).

Your object tables can be simply loaded again using the file icon under ‘Telescope’ – > ‘Movement’ – > ‘Mark/Move Table’. Selecting and applying an object in the table will load the object’s coordinates as the ‘Next Object’ to slew to in the main window (clicking ‘Start Slew’ will slew the telescope to the target as usual). You will not be able to have more than one table open at a time.

WinTCS also has an internally stored library of objects bright stars and interesting objects, (some Southern Hemisphere) from the “Sommers-Bausch Observatory Catalog of Astronomical Objects”. This can be accessed using ‘File’ – > ‘Movement’ – > ‘DFM Object Library’ (Figure 2.7, bottom panel) .

2.4 Adjusting Parameters

Altering the track rates

To change the track rates go to ‘Telescope’ – > ‘Movement’ – > ‘Rates’ – > ‘Track Rates’ (as show in Figure 2.8, top panel). The default RA tracking value is 15.04 which applies to tracking near 0 HA. For far East tracking, the track rate may need to be adjusted to as much as 15.07 arcsec/sec. The Dec rate generally only needs adjusting when the telescope is quite low in Dec, from ~ -0.001 arcsec/sec (when the telescope is East of the peer) to $\sim +0.0005$ arcsec/sec (when the telescope is East of the peer).

The handpaddle set and guide rates (fine-adjustment speeds, fast and slow respectively) can be set by going to ‘Telescope’ – > ‘Movement’ – > ‘Rates’ – > ‘Handpaddle Rates’ (Figure 2.8, bottom). All changes have to be affected by clicking ‘Apply’.

Adjusting the Focus

To adjust the focus in WinTCS go to ‘Telescope’ – > ‘Misc’ – > ‘Focus/Harmonic/Shutter’. Depending on the wavelength band, optimum focus is between $\sim 499-530$. This value is displayed as the ‘Analog Focus’ value on the main WinTCS screen on the left-hand side (in the ‘Misc’ box). Change the focus value in the text box and click ‘Apply’. Note that WinTCS is not very sensitive to small focus adjustments, i.e. you will have to change the focus value by, say, 5 units before the Analog Focus value will be seen to change by 2 units. Therefore to make small focus adjustments it is easier to simply use the focus buttons on

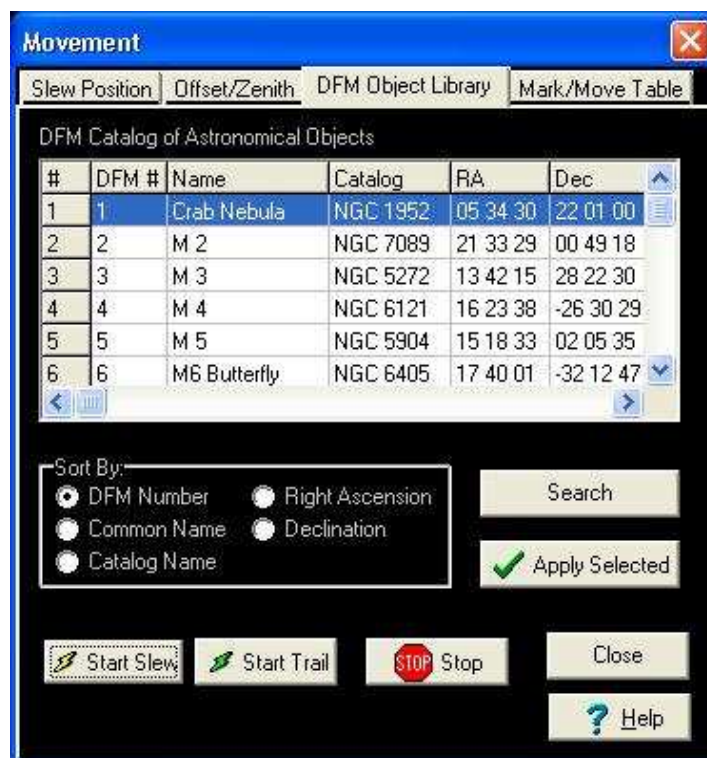


Figure 2.7: (Top) Creating your own object library. (Bottom) Loading an object from the WinTCS internal catalog.



Figure 2.8: Adjusting telescope track rates (top) and handpaddle rates (bottom).

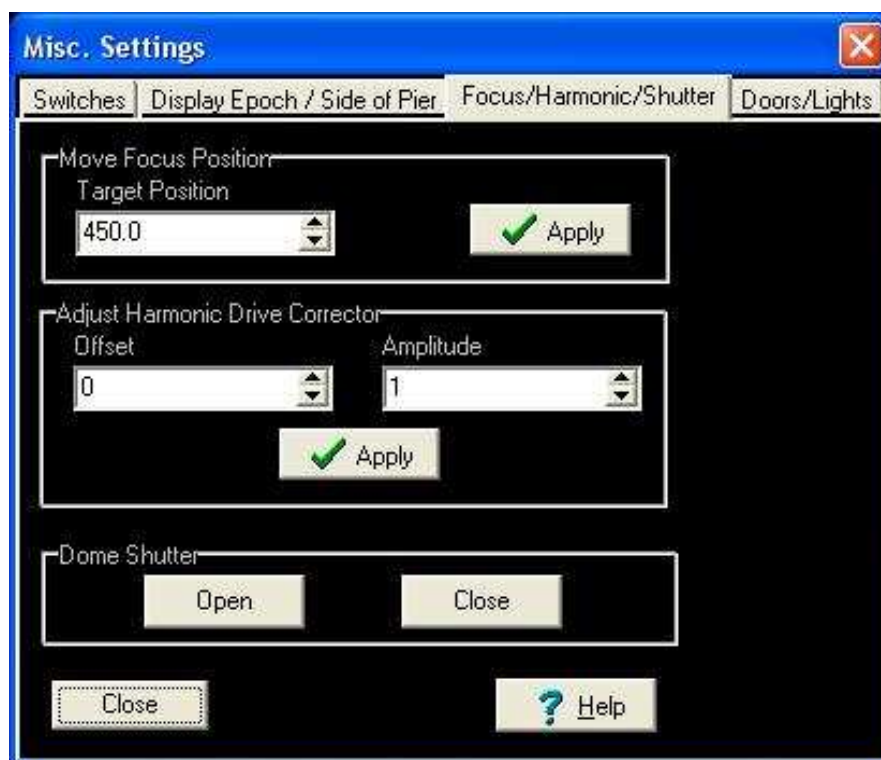


Figure 2.9: Adjusting telescope focus position.

the handpaddle situated in the warm room (fixed under the time display panel).

2.5 Shutting Down

2.6 Tips and Points-to-Note

Going over the Limit:

There is a mercury limit switch assembly mounted on the polar axis which provides hardware limits for the servo motor. The mercury switches interrupt power to the motors if the telescope tube assembly is driven too close to the horizon. WinTCS will warn you if you are approaching the limits (under the 'Operating Mode' box in the centre of the main screen) but if you should reach the limits then power to the motors will be interrupted and you will not be able to drive the telescope out from WinTCS. The telescope has to be manually driven back out of the limit using one of the handpaddles to recover control

of the telescope, and thereafter WinTCS can be used to move the telescope as normal.

Stopping any Telescope/Dome Action:

To stop the telescope or dome in mid-action (dome shutter closing, telescope slewing to position etc), or to cancel the 'Next Object', click the 'Stop' button on either the main window or the movement menu.

If you need to shut-down in a hurry (sudden cloud-burst for instance), flick the 'EMERGENCY SHUT-DOWN' toggle switch on the Auxillary Control panel in the to dome 'ON'. Note this will also cut power to the telescope drives so you will have to press the push button on the Grubb-Parson's box to re-supply power to the telescope afterwards.

Note: Never restart the TCS computer.

Chapter 3

Using the UCT CCD to Fine-Tune Telescope Focus and Position

3.1 The University of Cape Town CCD (UCT CCD)

Traditionally the 0.75m has the Infrared Photometer MkII and the UCT Photometer with Polarimeter as instrument accessories. Since 1995, the UCT CCD has been added to the suite. The camera was designed for high speed photometry operated in frame transfer mode. Frame transfer allows for exposure times as short as 10 seconds with no dead time for readout. Following the refurbishment of the telescope in 2006, the intention is for the UCT CCD camera to be, eventually, exclusively dedicated to the telescope.

This section of the manual only describes target acquisition and focusing using the UCT CCD in conjunction with the 0.75m TCS, WinTCS. The user is expected to be well acquainted with the UCT CCD's control software, 'wrwind', and its user manual 'The UCT CCD Photometer, Version 2.0.' by L. Homer, Dr D. O'Donoghue and Dr P. A. Charles (1999). Please refer to the UCT CCD's manual before continuing with the rest of this section.

3.2 Target Acquisition for Fine-Tuning Position

To set the telescope and camera up for target acquisition open up the dome and start-up the telescope as described in the previous chapter. Start up 'wrwind' on the instrument PC and perform the series of 'health checks' on the CCD as detailed in the UCT CCD's

user manual (chapter 2.3). Set up the CCD camera for exposure in frame transfer mode, 1×1 binning, ‘Gain’=1 (for bright stars). The telescope should be roughly initialised using the handpaddle, laser and West-wall pointer in the dome as described in the previous chapter. **Note:** The camera has a small field-of-view on the 0.75m, 1.5×2.5 arcmin, so the success of finding a bright star near the edge of the chip is a little sensitive to the orientation of the chip. Pointing on the 0.75m is best when the *long* axis of the chip is aligned with the Dec axis.

Now look for a bright target as follows:

- Identify a bright star near the zenith and set the telescope to slew to target as described in the previous section (make sure the telescope and dome are set to track on the Motor Driver Chassis in the dome).
- In the dome, use the handpaddle attached to the bottom of the telescope to move the star to the centre of the cross-hairs of the telescopic view finder attached alongside the telescope tube.
- Take a 1 second exposure (for 3rd-4th magnitude stars). Hopefully the star should appear on the edge of the chip. If not, take longer exposures until you can see the diffraction spike (due to the very small FoV afforded by the UCT CDD, the rough initialisation rarely produces the bright star on the chip. This fine-tuning process usually requires a few iterations of slewing and exposing before the star is found).
- Set the camera to make quick exposure readouts by selecting ‘video-viewing mode’ under the CCD menu. Set the exposure time for 1-2 seconds.
- While the camera is clicking away in video mode, move the telescope (at ‘guide’ speed) using the handpaddle in the warm-room (situated under the time-display panel). **Note:** be sure of the camera’s orientation. Centre the bright star on the chip.
- Exit video-viewing mode (by pressing ESC) and initialise the telescope to the new object position as described under the initialisation section in the previous chapter.

Note: If the next target is more than $\sim \pm 2$ HA away from the zenith and $\sim \pm 20$ degrees from the zenith, it is usually best to re-initialise the telescope on a bright target between the zenith and the next object position. Otherwise the next target will most likely not fall on the chip area.

3.3 Setting Focus

Once the telescope has been initialised to a bright star you can run a focus test. Make sure the focus value is between ~ 499 -530 as displayed as the ‘Analog Focus’ value on the main WinTCS screen on the left-hand side (in the ‘Misc’ box). If not, adjust the focus to this range as described in the previous chapter.

Choose a suitable E-region star (6^{th} – 8^{th} magnitude) according to the colour filter you want to observe in. There is usually a list of E-region stars situated in the warm room. Once you have slewed the telescope to the E-region target, take a 1-2 second exposure.

Now, on the UCT CCD’s program menu, go to ‘Image’ – > ‘Fit Gaussian’. This should produce a set of green cross-hairs on the UCT CCD’s image screen. Using the arrow keys move the cross hairs over the centroid of the star image and press ‘Insert’ (make sure that ‘Numlock’ is off before trying to press insert, see the UCT CCD User Manual for further details). On the UCT CCD screen the statistics of the gaussian fitted to the image should be given: full-width at half-maximum along the x-axis ($FWHM_x$), full-width at half-maximum along the y-axis ($FWHM_y$) and the peak of the gaussian. Note down the gaussian statistics and then adjust the focus by 1-2 units (refer to previous chapter for making focus adjustments). Again take another 1-2 second exposure and fit a gaussian to it. Note these gaussian statistics down and compare them to the previous set. Keep adjusting the focus until you obtain the gaussian with the narrowest $FWHM_x$ and $FWHM_y$ values. This will be your optimum focus. **Note:** Make focus tests some time after flat-fields have been taken and the sky brightness has stabilised. This avoids falling sky brightness interfering with the image measurements.

Chapter 4

Troubleshooting and Known Issues

4.1 Troubleshooting

The telescope pointing has gradually been getting worse

Did you initialise the Universal Time or set the CPU clock at the beginning of the evening? This must be done at the beginning of every run as the CPU clock does not keep perfect time over periods longer than a day.

The telescope lost pointing after moving to a new target

You may have mistaken the ‘Initialisation’ menu for the ‘Movement Menu’ when setting the target coordinates. The best way to check is to turn telescope tracking off and slew the telescope to zenith. Check with the laser guide and pointer whether the telescope is in fact pointing at the zenith. If not, initialise the telescope using the laser guide and pointer as described in section Chapter 2.3.

Alternatively, if you used the WinTCS auto-initialisation feature, the loss of pointing may be due to the issue described in the next section.

I can’t find my targets after initialising using the WinTCS auto-initialisation procedure

Have you initialised the telescope twice using the fiducials? See the next section has to how and why this needs to be done and what to do if this still doesn’t work.



Figure 4.1: Re-initialising the dome position under the Initialisation screen.

I can't switch the red dome floor lights off

Check that they aren't switched on at the wall switch near the top of the stairs. If not, see below.

The dome shutter, lights and/or mirror cover are unresponsive

Check that there is power to the Auxillary Controller box near the MDC crate (the red power light should be on) and all the switches are set to 'AUTO' (instead of 'MANUAL'). There is a radio transceiver box fixed to the dome wall near the wind-speed dial. This radio box transmits the dome shutter/lights commands to the transceiver box fixed on the dome, so check that it also has power (toggle switch on the side). If none of this works then contact the duty electronics technician, or if possible Mr Piet Fourie (refer to 'Useful Contacts', next chapter), and report the auxillary control fault.

The dome is not tracking the telescope properly

On certain areas of the sky, the dome tracking and movement is not perfect and on rare occasions the dome can obscure a small fraction of the mirror for a few minutes before it is given the instruction from the WinTCS to move over. Unfortunately the effect is not constant at all angles or positions of the telescope and the problem is not due to a constant dome offset.

If this should happen, switch off power to the dome by flicking off the ‘Autodome’ switch on the MDC crate. Move the dome manually using the handpaddle so that it is in line with dome shutter. Go to ‘Telescope’ – > ‘Initialisation’ – > ‘Other Positions’ and click ‘Use Telescope Azimuth’ (as shown in Figure 4.1). Click ‘Apply’ to re-initialise the dome to its new position before switching its power back on.

4.2 Known Issues

4.2.1 Pointing Problems and the WinTCS Auto-Initialisation Procedure

When the TCS is requested to auto-initialise, the TCS slews the telescope to a position of ~ 0.5 HA from the zenith, then slowly tracks the telescope in positive HA while the TCS looks for the position encoder’s fiducial signal. In July of 2007 it was discovered that the TCS did not consistently find the RA fiducial in the correct position. The reason is, if the telescope is set by the potentiometers to a start position which just misses the correct fiducial position then the TCS will only detect the signal on the next turn of the encoder (2 arcmin later) but still initialise the telescope to the previous fiducial position (as this is the value stored in the TCS). This results in the telescope, once ‘initialised’, frequently finding targets at either plus or minus 2 arc minutes.

This usually occurs when the telescope has to slew for a few hours to the starting position. In August 2007, after many initialisation checks and testing of the RA encoder, it was discovered that the problem of incorrect initialisation arose when the telescope had to slew from a far east position ($< -1\text{HA}$) to the initialisation starting position. When slewing from West to East, starting from the zenith or west of it, the telescope would always be left within one encoder turn of the correct fiducial position and so initialise correctly. When slewing from East to West, starting from a position greater than -1HA from the zenith, the telescope just overshoots the correct fiducial position and so finds (and

initialises to) the next one + 2arcmin from where it should be. The greater the distance the telescope has to slew from -HA to the starting position, the further westwards it would overshoot, the largest error being ~ 1 arcmin. This suggests a balancing problem.

Adjusting the balancing of the telescope to compensate for such a small error would be too difficult to do in practice therefore a change in the user's initialisation procedure is suggested to counter the problem: the observer should initialise the telescope, using the fiducials, twice (see Chapter 2.3, 'Fine Initialisation: Using the Telescope Auto-Initialisation feature').

The first initialisation is made under the assumption that the telescope could possibly be far East of the zenith (although the observer will visual feedback of the telescope's position). Then the user requests that the telescope slew to zenith. We can be certain that the telescope will lie either at the zenith or 2 arcmin away from it. Then the user requests the TCS to find the fiducials again. This time the RA fiducial should be found in the correct position and the remote observer can sure the telescope has been initialised correctly.

Note: This double initialisation procedure is not failsafe. To check that the pointing is not off by 2 arcmin, request the telescope to slew back to zenith after the second auto-initialisation with the fiducials (presuming you first made sure the laser pointer was in the centre of the cross-hairs on the West wall when first starting up). If the laser pointer does not fall anywhere on the pointer sheet on the West-wall then the telescope pointing is still off centre by ± 2 arcmin. In this case, re-initialise the telescope using the laser pointer as described in chapter 2.3 and use a bright star for fine-tuning the position instead.

It was found that once the telescope is initialised, stars between + 1 and -4 in HA and -80 and +20 degrees in Dec (nearly the full range of the telescope in Dec) can be successfully found to fall within the field of view when the telescope is slewed from the zenith. Slewing to targets which lie at greater than +1 HA can be achieved by performing successive initialisations on bright stars in ~ 1 HA steps approaching the target.

Chapter 5

Quick Set-up Guide/Procedure

START-UP PROCEDURE

1. Switch on power on the black, wall mounted “Grubb Parsons” box in NW corner of the dome.
2. Switch MTR DRIVER CHASSIS ON on the front panel of the motor driver chassis (MDC) crate (white toggle switch).
3. Switch DRIVES ON (Switch up)
4. Push HALT MOTORS button out (this switches the motors on, the switch should now be red)
5. Set DOME TRACK to HOME.
6. On the controller box mounted on the wall next to the MDC make sure that the switches are in the following configuration:
 - MANUAL/AUTO toggle switch set to AUTO
 - RAIN SENSOR toggle switch set to ON
 - EMERGENCY SHUT-DOWN toggle switch set to OFF
 - DOME LIGHTS switched to OFF and CIRCLE LIGHTS
 - MIRROR COVER set to CLOSE

7. Login to windows as observer, password: Saaobserver. Start WinTCS (double click the yellow DFM TCS shortcut on the Desktop). Let WinTCS auto-initialise. It initialises assuming that the dome is parked west and the telescope is at the zenith.
8. Make sure the dome *is* in its parked position (WEST, 270 azimuth). If it isn't, move the dome using the handpaddle so that the centre line of the dome slit is aligned with the arrow on the west wall.
9. Make sure the telescope *is* at the zenith i.e. using the handpaddle, align the telescope using the laser (red button at the bottom the telescope tube) with the arrow diagram on the west wall.
10. If the dome and telescope had to be re-aligned, to the West and zenith respectively, restart WinTCS.
11. On the MDC front panel, switch AUTO DOME ON. (Switch up).
12. Switch DOME TRACK ON.
13. On the TCS Menu go to Telescope – > Intialization – > Date/Time. Set the date and time (Note: time is in UT).
14. On the TCS Menu go to Telescope – > Misc – > Focus/Harmonic/Shutter. Switch off the lights and open the dome. Go to Telescope – > Misc – > Lights/Cover and uncover the mirror (Note: **always** open the dome before you uncover the mirror).
15. (OPTIONAL:) To intialise using the telescope's auto-initialisation feature go to Telescope – > Intialization – > Telescope Position and click on 'Initialise with Fiducials'. Wait for the telescope to find the HA and Dec fiducials. Then go to Telescope – > Movements – > Offset/Zenith, click on 'Slew to Zenith' and 'Apply'. Then re-initialise using the fiducials again (see 0.75m TCS manual as to why this should be done twice).
16. On the MDC front panel, switch TRACK ON. (The TRACK/AUX TRACK switch should always be set to track).
17. On the TCS Menu, go to Telescope – > Movements – > Set slew position. Input the RA, Dec and Epoch of a bright star to check the pointing. Click "Apply", the star's coordinates should appear as "Next Object" on the Main menu and "SLEW

ENABLED” should appear in the status bar. Click “Start Slew” from either the Movements menu or the Main menu (they can be left open concurrently). Alternatively, go to Telescope – > Movements – > Mark/Move table. Click on the file icon, “Load Table” and select “Bright stars”. This is a .mrk file that contains a small selection of bright stars. Select an entry then click “Apply selected” then “Start Slew”.

18. Centre the star in the view-finder using the handpaddle. Go to Telescope – > Initialization – > Telescope Position and click “Use Next Object position”. A dialog box should pop up asking whether you are sure you want to initialise. Click “Yes”.
19. The telescope should now be initialised and you are ready to observe.

SHUT-DOWN PROCEDURE

1. On the MDC front panel, switch TRACK OFF.
2. On the TCS Menu go to Telescope – > Movements – > Set zenith position. Click “Apply” and “Start Slew” to slew to the zenith. Wait for the telescope to slew to the zenith.
3. Go to Telescope – > Misc – > Lights/Cover. Close the mirror cover (Note: **always** close the mirror cover before closing the dome shutter). Go to Telescope – > Misc – > Focus/Harmonic/Shutter. Close the dome shutter.
4. Set DOME TRACK to HOME on the MDC front panel. Wait for the dome to go home.
5. Switch AUTO DOME OFF.
6. Switch DRIVES OFF.
7. Push HALT MOTORS button in (the switch should now be green).
8. Exit WinTCS.
9. Logout of Windows (Note: **do not** shut down the computer).

10. All toggle switches should be down except TRACK/AUX TRACK and EXTERNAL COMPUTER.
11. Switch MTR DRIVER CHASSIS OFF (white toggle switch).
12. Switch off telescope power on the “Grubb Parsons” box in NW corner of the dome.
13. Turn Master switch OFF at entrance to dome.

Chapter 6

Useful Contacts

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